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***RATS and COCONUTS  
in the  
MARSHALL ISLANDS***

by  
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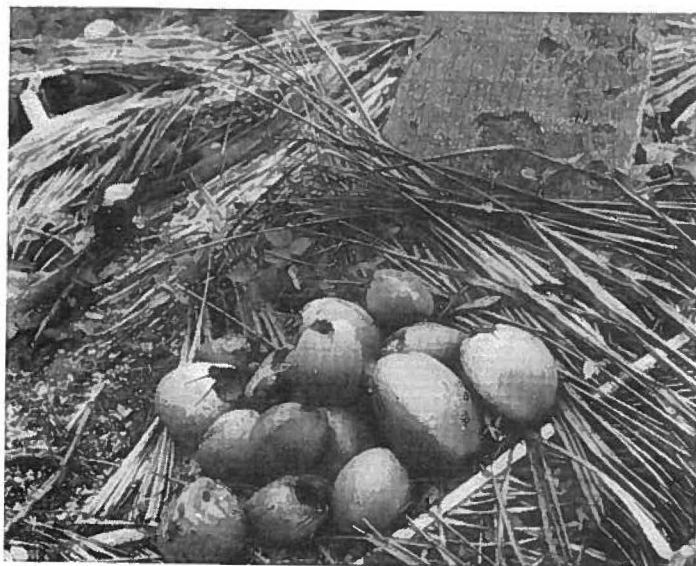
## INTRODUCTION

**I**NFESTATIONS of rats in coconut groves throughout the tropics lead to much loss in yields. In some parts of the Pacific, rat damage to coconuts has been reported to be as high as 60 per cent. Reports from Tonga and Tahiti have indicated damage as high as 40 per cent, while Fiji reports damage totalling 28 per cent. In highly infested areas of Jamaica, a figure of 35.6 per cent loss to rats has been recorded. The economic importance of rat infestations in coconut groves has not been investigated to any reliable degree, although its significance is often forgotten or ignored in most copra producing areas. However, in highly populated atolls where dense populations rely heavily on copra production, the rat is considered a very serious problem. Its competition with man for coconuts as food causes heavy losses and is a serious problem where control measures are not practised to reduce rat infestation.

Rats generally climb palm trees to gnaw into young nuts for the coconut water and gelatinous kernel material. Holes measuring about 1.5 inches in diameter are gnawed near the stem end of the nut. The size of nuts generally attacked ranges from 4 to 7 inches in length at which stage the nuts are immature and most vulnerable to damage because of their tender husks. The damage ranges from slight scarring of the husk to complete penetration of the soft shell. Injury to the nuts causes premature dropping from the bunch and an accumulation of damaged nuts under the trees.

Some trees, because of their tender nuts, are much more favoured than others. It is not uncommon to encounter individual trees heavily attacked by rats while nuts of neighbouring trees go untouched. It is generally believed that rats cause damage to coconut flower stalks before and after dehiscence, and also to young "button" coconuts.

Control measures for rat abatement to reduce coconut loss are not practised to any great extent in copra producing areas. Metal banding on palm trees has been practised in a few countries with some success, but this method is not feasible in overcrowded and overgrown groves where rats have access to trees by climbing adjacent palms and shrubs. Untended, overcrowded groves are at present the general rule in the majority of the islands. Banding is effective only in properly spaced groves. Trapping has



Injury to nuts causes premature dropping from the bunch and an accumulation of damaged nuts under the tree.

been tried to some extent, but is not a common practice. Development of anticoagulant baits has shown promise in reducing rat populations, but these baits have not been fully tested for effectiveness in the field.

In order to arrive at some fairly reliable estimate of the extent of rat damage in coral atolls and to determine the effectiveness of trapping, surveys were conducted in Wotje Atoll in the Marshalls. Also, to assess the effectiveness of rat baits, rat control trials utilizing anticoagulants in coconut groves were conducted on Nama Island in the Central Caroline Islands.

Wotje Atoll is located in the Northern Marshalls, approximately 170 degrees East Longitude, and 9 degrees 25 minutes North Latitude.

Nama Island is located 152 degrees 35 minutes East Longitude and 7 degrees North Latitude. The annual rainfall in Wotje approximates 100 inches, and is much higher in Nama where yearly rainfall is estimated at between 130 and 140 inches.

## VARIATIONS OF RAT DAMAGE IN PALM GROVES

The island of Ormij in Wotje Atoll was selected for the survey because of the diversity in the coconut groves. Ormij is typical of most atoll islands, where coconut groves are ill-kept and in want of rehabilitation work. In most cases the groves were in need of thinning and bushing. A highly competitive condition existed between cultivated palms and wild vegetation for sunlight, nutrients, and soil moisture. Four test plots of one acre each were measured and their boundaries clearly defined with stakes. The general appearance of the plots was an important criterion in their selection so as to obtain a diverse representation of coconut grove conditions.

Plot 1 was selected for its relative dryness and sparseness of wild vegetation. Much of the grove was covered by low grasses and scattered stands of low shrubs such as *Tacca leontopetaloides*, *Euphorbia heterophylla*, and *Polypodium scolopendria*. Forty bearing palms and five seedlings made up the coconut stand.

Plot 2, which was located about 200 yards equidistant from the ocean side and lagoon shores, possessed a heavier growth of underbrush than Plot 1. The underbrush included *Wedelia biflora*, *Ipomoea tuba*, and *Cassytha filiformis*. The density of 55 coconut palms and 25 seedlings was the highest among the four plots. Large trees of *Pandanus*, *Morinda citrifolia*, and *Guettarda speciosa* were found among the palms.

Plot 3 was situated in the center of the island, approximately 500 yards from the ocean and lagoon shores. This plot possessed thick stands of *Pseuderanthemum reticulatum* and *Wedelia biflora* in isolated areas. Forty-seven mature palms and six seedlings were found among many large trees of *Pandanus* and *Guettarda*.

Plot 4 was located on the south end of the island. A low density of 42 bearing palms and eight seedlings made up the coconut stand. Large numbers of pandanus and thick stands of *Ipomoea tuba* and *Polypodium scolopendria* made harvesting of fallen nuts difficult. Much debris including coconut husks, fronds, and trash was piled in large heaps throughout the plot. A very thick stand of strand vegetation was located on the ocean side. No fresh water source was available on any of the four plots.

## NUT COUNT AND RAT ACTIVITY

Copra nuts and rat-damaged nuts were tallied at two-week intervals for a period of three months. All fallen nuts were counted and removed from the plot in order that none would be recounted in subsequent weeks. No nuts were harvested from the trees. Since all rat damage was of arboreal origin and no damage occurred after dropping of mature nuts, removal of the nuts from the plots is believed to have had little or no effect on rat activity in the plot. No attempt was made to estimate the amount of damage caused to flower stalks and nuts smaller than 2 to 3 inches in length.

A count of palms showing rat activity in their crowns was also made for each of the plots. All palms in the plots were climbed to determine the presence of nests and occurrence of damaged nuts.



A rat-damaged coconut.

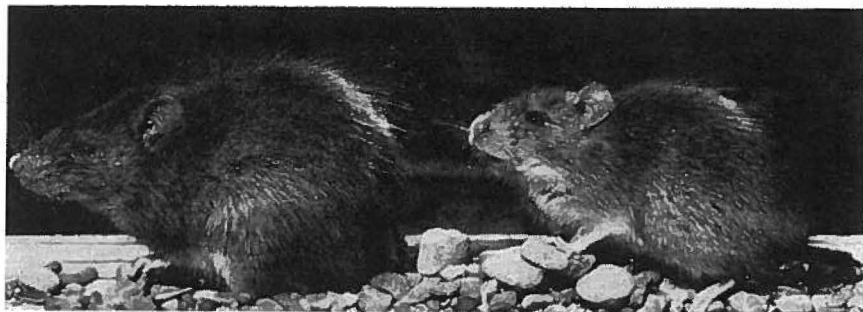
The results showed that a highly variable incidence of rat damage occurs on coral atoll islands. As the data shows, rat damage is higher in the interior of the island where more harboring sites and less intrusion by man and domesticated animals occur. Results also show that thick undergrowth favors rat populations, e.g. the high rat damage in Plot 3 where much vegetation was found. The least amount of rat damage occurred in Plot 1

(10.6 per cent as compared to 63.3 per cent in Plot 3) and this may be attributed to better management of the grove. Rat activity in coconut palms was highest in Plot 4 in which 25 of the 42 mature trees or 59.5 per cent were under attack by rats. Plot 3, with the highest percentage of infestation, showed 48.9 per cent of the trees affected by rats, while Plot 1, with the lowest amount of rat damage, had only 27.5 per cent of the trees affected by rats.

The number of nests found in each plot seemed to have no bearing on the amount of rat-damaged nuts. Plots 1 and 2 had three nests; Plot 3 showing the highest incidence of rat damage had only two nests; and Plot 4 with only 21.8 per cent damaged nuts was found with four nests. Nests were usually made of dry grass and coconut cloth-like stipules at the juncture of the leaf attachment and the stem. No nest was found harboring rat litters in any of the plots.

## CONCLUSION

It is known that regular maintenance of groves and sanitary practices discourage rat activity by the elimination of protective cover and harboring sites, and thereby reduce rat damage to coconuts. In the four plots, differences as high as 50 per cent in rat damage of nuts existed between the best managed groves and the poorest. In terms of annual income, as much as \$35 was lost in the poorest plot as compared to \$6 per year loss in the best plot, based on local market value of copra. Other plots showed an equivalent loss of \$21 to \$25 per year. From the results it can be concluded that systematic maintenance of coconut groves directly contributes to reduce substantial losses of grove income.



Polynesian rat (*Rattus exulans* Peale).

more active in foraging habits at this time as only two females were caught during trapping.

While it has not been ascertained whether Polynesian rats as well as roof rats were the cause of nut damage in the trees, there is a strong indication to believe so. If the Polynesian rats were unable to climb to the tops of palms, there would certainly have been evidence of damage to mature fallen nuts on the ground as is the case in some atolls where rats for some reason are averse to climbing coconut palms. For instance, the author has witnessed large populations of non-climbing Polynesian rats gnawing through mature fallen nuts when soft, succulent, immature nuts were readily available in large numbers on short palms in the Northern Marshalls.

## CONCLUSION

After six nights of trapping, reduction of damaged nuts was lowered from 31 per cent to 12.7 per cent. Further trappings would probably have reduced the damage to a much lower level. From the results, trapping of groves can lead to a significant reduction in the incidence of rat damage; however, periodic trapping should be continued to eliminate reinfestation from adjacent areas.

## USE OF ANTICOAGULANT BAITS TO CONTROL RATS

To evaluate the effectiveness of anticoagulant baits in coconut groves, tests were conducted on Nama Island for a period of five months. Three plots were selected on the basis of differing grove conditions, taking into consideration tree density, general condition of the groves, and the extent of bush growth. The number of bearing palms varied from 41 in Plot 2 to 96 in Plot 1. For a period of ten weeks the copra nuts and rat-damaged nuts were tallied to determine the percentage of prevailing rat damage in the plots. Counts were made every two weeks, and all nuts were removed from the plots to prevent recounting of the nuts. There was no evidence of damage to mature, fallen nuts. No doubt, all damage was arboreal and tree-borne, and the removal of nuts is believed to have had little influence on the rat damage in the trees. The damage was found to be 20.8 per cent for Plot 1; 19.5 per cent for Plot 2; and 27.3 per cent for Plot 3.

After the tenth week, inverted "T" dispensers were placed in the plots and filled with "Ratafin" bait (oats-hydrocoumarin). These dispensers were made from polyethylene plastic tubes which each held 2 lb of bait. Two dispensers were placed in each plot; however, to lessen reinfestation from adjoining groves, dispensers were also placed surrounding the test plots at the rate of two dispensers per acre. These dispensers were checked each week to refill those which were empty.

Four weeks after the baited dispensers were applied, a noticeable decrease in damaged nuts was evident. It must be remembered that damaged nuts tend to remain attached to the bunches for two to three weeks after injury, and therefore, the decrease in damage was not noticed immediately.

Ten weeks after baiting, the percentage of damage was down to 5.8 per cent in Plot 1; 6.6 per cent in Plot 2; and 4.9 per cent in Plot 3.

In comparison to the original number of nuts damaged in the plots, by the 20th week the number of nuts damaged was lower by 58.8 per cent, 50 per cent, and 65.6 per cent respectively. After ten weeks of rat bait application, a residual damage of 5 per cent to 7 per cent remained. This may be indicative of the constant reinfestation from adjoining areas or

non-consumption of bait by some rats. Thus, while baiting will reduce the amount of rat damage in an area, complete eradication is probably not possible through the use of baits alone.

## SUMMARY

Surveys on the extent of rat damage to coconuts and the effect of trapping were conducted in the Marshall Islands. Evaluation of anticoagulant baits was made in Nama Island in the Caroline Islands. The results of these surveys showed that rats favor ill-tended groves where tall grasses, underbrush, and trash provide shelter and protection. Untended groves exhibit a high percentage of damaged nuts. In one test plot where heavy underbrush was found, rat damage was as high as 63 per cent over a period of 14 weeks. In terms of lost revenue, the number of nuts damaged during a year equalled \$35 per acre in this plot, calculated on the current price of copra at \$110 per short ton. In a well-tended grove the damage was only 10.6 per cent by comparison. This is a clear indication that sanitation of groves is an important factor in reducing rat damage.

Underbrush which is cut periodically tends to inhibit rat populations because of the lack of sufficient protection and shelter. (Coconut husks and fronds piled into large heaps are inviting nesting sites for rats; all trash should be buried or spread around palms as mulch.)

In the trapping tests it was found that a few nights of trapping will reduce rat damage considerably. Six nights of trapping yielded 16 rats of both *Rattus rattus* and *Rattus exulans*. As a result, damage was reduced from 30 per cent to 12.7 per cent; however, it is assumed that human activity in the groves to set traps and make nut counts or seasonal fluctuations in rat damage had no effect on the normal habits of the rat population within the grove, and this reduction is due to the results of trapping. Had trapping continued, the incidence of rat damage may have been further reduced. Eight weeks after trapping was stopped there was a slight increase in damaged nuts which may have been due to reinfestation from adjoining groves. A longer period of nut counts would have probably shown a gradual rise in damage to a point equal to or close to the damage prior to trapping.

Application of anticoagulant baits resulted in dramatic decreases in rat damage to test plots. Because of the limited time available in conducting these tests, it is uncertain whether longer periods of baiting will completely eradicate rats from a grove, but it is certain that baits will significantly reduce damage in groves showing a high incidence of loss.

## RECOMMENDATIONS

Rat control programs in coconut groves should be effected in all islands sustaining large amounts of rat damage. Where rats account for a high proportion of crop loss, proper control measures are economical. To obtain the best results, control measures on a continuous basis embracing entire islands are recommended. The most effective method in reducing damage is by sanitation. Well-kept groves have less damage. Periodic bushing of groves to keep grass and shrubbery to a minimum and thereby eliminate harboring sites and vegetative protection will do much to lessen rat infestation.

Trapping and baiting will reduce the rat population where damage is high. However, only if field maintenance is practised will the results of trapping and baiting have any prolonged effect, for groves favorable to rats will soon be reinfested from other areas and damage will recur. The ideal situation in rat control is one that covers entire islands or large areas which encompass year-round grove care, along with alternating trapping and baiting schedules until the incidence of damage approaches close to zero. Alternate trapping and baiting will ensure eradication of trap-shy as well as bait-shy rats. Control measures applied to small plots will only bring small relief because of reinfestation from adjacent groves. Because of reinfestation, continual control measures covering entire islands are needed to ensure effective rat abatement.

Any serious rat control program should include a schedule of regular grove care and maintenance followed by a week of trapping and two weeks of poisoning. Whenever traps are set in a field, attachment to palm trees will lessen disturbance by nocturnal scavengers. Traps placed on the ground frequently snare foraging crabs. Bait stations should also be checked weekly to refill empty dispensers. During trapping intervals it is most important that traps are checked at least once a day, preferably in the morning, to eliminate trapped rats, replace baits, and reset disturbed traps. It is most likely that in heavily infested areas, damage to nuts will not be completely eliminated; therefore, several more weeks of alternate trapping and baiting will be necessary. When rat damage to coconuts is high in any island, community efforts to reduce damage on the entire island are very important. No one method alone, whether it is sanitation, trapping, or baiting, will be effective in complete control of rats in coconut groves. Any serious effort to control rats will require the full use of the three methods.

**RAT DAMAGE SURVEY**  
**ORMIJ ISLAND, WOTJE ATOLL**  
**MARSHALL ISLANDS**

**PLOT CONDITION**

**PLOT #1**

**Size:** 1 acre.

**Location:** North side of island, 200 yd from ocean and lagoon fronts.

**Plant species in grove:**

- (1) Coconut: 40 mature trees, 5 seedlings.
- (2) Pandanus: 10 trees.
- (3) Breadfruit:
- (4) Banana:
- (5) Understory:
  - (a) *Tacca leontopetaloides*.
  - (b) *Polypodium scolopendria*.
  - (c) *Euphorbia heterophylla*.
  - (d) Low grass of unknown species.

**General appearance:** Area is relatively drier than other three plots. No thick underbrush found, only small shrubs and low grass cover. Three large bomb craters found in plots; no water source in the area or nearby.

**RAT ACTIVITY IN PALMS**

Trees with damaged nuts = 11.  
 Trees with old nests = 3.  
 Trees with active nests = 0.

**PLOT #2**

**Size:** 1 acre.

**Location:** Toward central portion of island, 200 yd from ocean and lagoon beaches.

**Plant species in grove:**

- (1) Coconut: 55 mature trees, 25 seedlings.
- (2) Pandanus: 13 trees.
- (3) Understory:
  - (a) *Morinda citrifolia*.
  - (b) *Guettarda speciosa*.
  - (c) *Wedelia biflora*.
  - (d) *Cassytha filiformis*.
  - (e) *Ipomoea tuba*.
  - (f) *Polypodium scolopendria*.
  - (g) *Tacca leontopetaloides*.
  - (h) Low grasses of unknown species.

**General appearance:** The understory is light, but much heavier than in Plot #1; *Wedelia* 1 to 3 ft high. No source of fresh water nearby.

**RAT ACTIVITY IN PALMS**

Trees with rat damaged nuts = 27.  
 Trees with old rat nests = 2.  
 Trees with active rat nests = 1.



### PLOT #3

**Size:** 1 acre.

**Location:** Central portion of island, 500 yd from ocean and lagoon shore.

#### Plant species in grove:

- (1) Coconut trees: 47 mature trees, 6 seedlings.
- (2) Pandanus: 10 trees.
- (3) Understory:
  - (a) *Wedelia biflora*.
  - (b) *Cassytha filiformis*.
  - (c) *Tacca leontopetaloides*.
  - (d) *Guettarda speciosa*.
  - (e) *Pseuderanthemum reticulatum*.

**General appearance:** Evidence of much burning six to eight months earlier, understory quite thick in isolated areas, thick stands of *Pseuderanthemum* on one end of plot.

#### RAT ACTIVITY IN PALMS

Trees with damaged nuts = 23.  
Trees with old rat nests = 1.  
Trees with active rat nests = 1.

### PLOT #4

**Size:** 1 acre.

**Location:** South end of island, 100 yd from ocean shore.

#### Plant species in grove:

- (1) Coconut: 42 mature trees, 8 seedlings.
- (2) Pandanus: 10 trees.
  - (a) *Polypodium scolopendria*.
  - (b) *Cassyth filiformis*.
  - (c) *Ipomea tuba*.
  - (d) Unidentified grass as ground cover.

**General appearance:** Thick stand of strand vegetation on ocean side of plot, large amounts of coconut husks, trash and fallen coconut fronds found in large heaps. No source of water available.

#### RAT ACTIVITY IN PALMS

Trees with damaged nuts = 25.  
Trees with old rat nests = 3.  
Trees with active rat nests = 1.

TABLE I

## RAT DAMAGE SURVEY, ORMIJ ISLANDS, WOTJE ATOLL

	PLOT #1			PLOT #2			PLOT #3			PLOT #4		
Date	Copra Nuts	Rat Damaged	Per cent Damage	Copra Nuts	Rat Damaged	Per cent Damage	Copra Nuts	Rat Damaged	Per cent Damage	Copra Nuts	Rat Damaged	Per cent Damage
5-20-66	305	32	9.5	131	154	54.4	70	177	71.6	427	130(F)	23.1
6- 2-66	71	13	15.5	36	30	45.4	38	37	49.3	89	14	13.6
6-17-66	72	2	2.7	32	37	55.2	32	83	72.2	92	28	23.3
7- 1-66	44	11	20.0	30	35	53.8	45	40	47.0	87	18	17.1
7-19-66	81	16	16.5	28	44	61.0	53	62	53.9	153	41	21.1
8- 2-66	74	6	7.5	15	25	65.8	25	44	63.8	75	25	25.0
8-17-66	54	3	5.3	15	21	58.3	23	46	66.6	98	30	23.5
Total	701	83	10.6	283	346	55.0	286	489	63.1	1021	286	21.8
Average	100	12	10.7	40	49	55.0	40	69	62.7	146	41	22.0
Loss*			\$6.00			\$25.00			\$35.00			\$21.00

\* Approximate annual loss based on local market value of \$110 per short ton.

TABLE II  
KIMEJIO ISLANDS, WOTJE ATOLL

Date	Copra nuts	Damaged	Per cent damage
May 23, 1966	2,298	321	43.9
June 7, 1966	332	154	31.7
June 20, 1966*	258	104	28.7
July 4, 1966	270	68	20.1
July 18, 1966	248	63	20.2
August 3, 1966	240	35	12.7
August 23, 1966	249	52	17.2
Total	3,895	797	

\* Six nights of trappings started after nut count on June 20.

TABLE III  
SPECIES OF RATS TRAPPED

	Rattus ratus		Rattus exulans		Total
	Male	Female	Male	Female	
6-21-66	0	0	1	2	3
6-22-66	0	0	0	0	0
6-23-66	0	0	5	0	5
6-24-66	2	0	3	0	5
6-25-66	0	0	2	0	2
6-26-66	1	0	0	0	1
	3	0	11	2	16

TABLE IV  
KIMEJIO ISLAND TRAPPING RESULTS

	6-21-66	6-22-66	6-23-66	6-24-66	6-25-66	6-26-66	Total
Trap success	3	0	5	5	2	1	16
Undisturbed	3	12	8	18	23	21	85
Sprung	20	17	15	5	2	5	64
Trap missing	2	0	1	0	0	0	2*
Bait missing	2	0	0	0	1	1	4
Trap nights	28	29*	28	28	28	28	169
Per cent success	10.3	0	18.0	18.0	7.1	3.4	

\* One trap recovered.

**TABLE V**  
**RAT DAMAGE SURVEY**  
**NAMA ISLAND, UPPER MORTLOCKS**

	PLOT #1	PLOT #2	PLOT #3
<b>1. Location</b>	South-east side of island.	Central portion of island, few hundred feet from ocean.	North side of island, inside of strand vegetation next to ocean.
<b>2. Coconut palm</b>	96	41	69
<b>3. Coconut seedlings</b>	28	60	90
<b>4. Breadfruit (Bearing)</b>	7	12	9
<b>5. Breadfruit seedlings</b>	2	0	0
<b>6. Banana</b>	5	0	0
<b>7. Pandanus</b>	2	30	10
<b>8. Papaya</b>	2	3	2
<b>9. Eugenia spp.</b>	0	0	0
<b>10. Others</b>	9	13	28
<b>11. Ground cover</b>	Polypodium ferns, Alocasia taro, and grasses. Low pandanus and banana also found.	<i>Wedelia biflora</i> , <i>Vigna marina</i> , <i>Tacca leontopetaloides</i> , <i>Scaevola frutescens</i> , and grasses. A few papaya, pandanus, and morinda.	<i>Scaevola frutescens</i> , <i>Polypodium ferns</i> , grasses along with a few <i>Morinda Citrifolia</i> , <i>Guettarda speciosa</i> , and pandanus.
<b>12. Grove condition</b>	Bushed occasionally, entire grove covered by coral rocks, boundary walls and rock piles made from coral rocks.	Slightly rocky with much more coral sand in soil. Grove maintenance adequate.	Coral rocks scattered throughout grove, not as much as Plots 1 and 2.

**TABLE VI**  
**RAT DAMAGE SURVEY**  
**NAMA ISLAND, UPPER MORTLOCKS**

	PLOT #1		PLOT #2		PLOT #3	
	Copra nuts	Rat-damaged nuts	Copra nuts	Rat-damaged nuts	Copra nuts	Rat-damaged nuts
1-10-69	100	22	88	35	90	38
1-27-69	102	34	98	40	87	28
2-10-69	91	31	76	28	92	24
2-24-69	188	51	188	23	54	45
3-10-69	164	32	161	23	104	24
<i>Total</i>	645	172(20.8%)	611	149(19.5%)	427	160(27.3%)

**Rat dispensers installed in plots with baits**

3-24-69	178	38	169	28	160	25
4- 7-69	230	19	192	18	138	24
4-21-69	211	12	203	14	192	16
4- 5-69	218	16	201	11	207	14
4-19-69	223	14	212	15	211	11
<i>Total</i>	1,060	99(8.5%)	977	86(8.1%)	908	90(9.0%)